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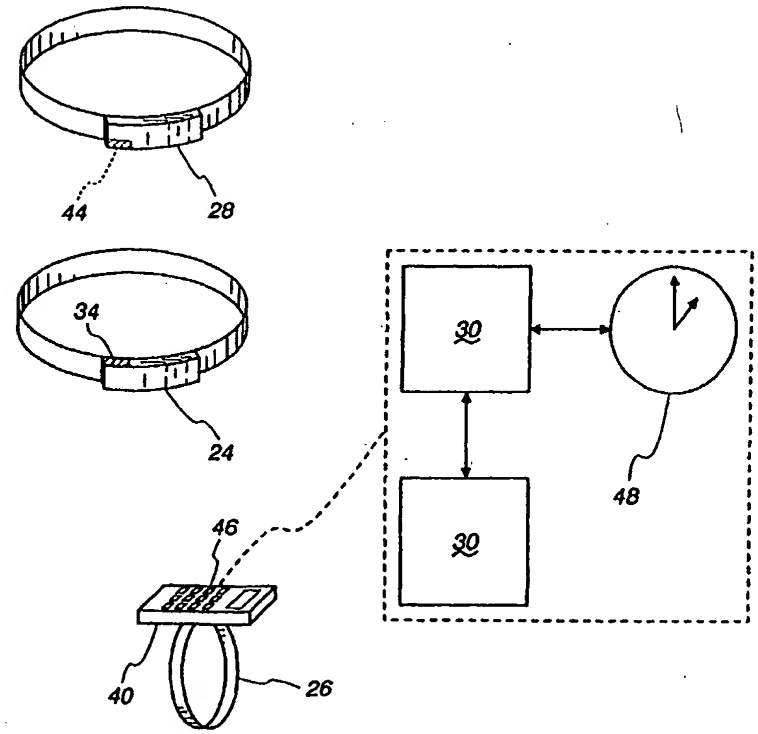
(57) Abstract

The pedometer having improved accuracy by calculating actual stride lengths of a user based on relative stride rates. The pedometer includes a waist or leg mounted stride counter, a transmitter for transmitting data to a wrist-mounted display unit, and a data processor for calculating necessary base units and actual stride rates and lengths. The pedometer can also interact with a heart monitoring device.



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PEDOMETER

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates generally to pedometers having a waist mounted stride-counting device and transmitter, and a wrist-mounted receiver and display. The invention also relates to a distance calculation device that calculates a distance walked or run based on an algorithm that converts a base stride length and a base stride rate to an actual stride length for use in calculating the distance traveled.

Pedometers are known which include devices or algorithms for determining the distance a person travels on foot. For example, U.S. Patent 4,371,945 discloses an electronic pedometer that calculates distance by electronically measuring the length of each stride taken by a user. Stride length is measured by ultrasonic waves generated by an ultrasonic module strapped to one leg and an ultrasonic detector worn on the other leg. A program compensates for a variety of measurement errors and the results are displayed on a wrist-mounted display after being transmitted by VHF waves from the leg to the wrist.

U.S. Patent 4,771,394 discloses a computer shoe with a heel-mounted electronic device with an inertia footstrike counter, a timer, a sound generating device, a battery, and a gate array for counting time and footstrikes to calculate distance and running time as a function of stride time. Although recognizing the important relationship of stride length and foot speed, the shoe in this patent requires data from at least 15 test runs or walks and the data must be user-entered in pairs of footstrikes and elapsed time to cover a pre-determined distance. Further, user adjustments of time must be performed to accommodate start and stop times, and the number of counted footstrikes is increased one percent to overcome inherent errors in the inertia step counter. The shoe-mounted device is subject to damage from impact, dirt, and water, and requires a stay-at-home computer with which to interface. There is no means disclosed to transmit data to a wrist-mounted display device or an "on-board" computing device that provides "real time" data to a runner.

U.S. Patent 4,855,942 discloses a pedometer and calorie measuring device that includes a wrist-mounted step counter and a fixed stride length to calculate distance traveled. Wrist-mounted step counters are known to be inaccurate because they assume a step for every arm movement. Even with error correction, such a device will provide less accurate step counts than a leg or waist-mounted counter. Further, fixed stride lengths do not take into account the fact that stride length varies with rate of movement.

U.S. Patent 5,117,444 discloses a pedometer and calibration method with two calibration modes. First, a user travels a predetermined "half-distance" for the device to count and store the number of strides in that distance. Next, the user travels a second distance with the step counter comparing actual steps to the steps in memory and a current trip memory are incremented by a tenth of a "whole unit" distance. There is no correlation between stride length and stride rate which requires the user to re-calibrate the device when walking as opposed to running.

U.S. Patent 5,475,725 discloses a pulse meter with pedometer function to determine pace and pulse rate of a user. The meter uses pulse wave base data compared to actual pulse wave data rates.

U.S. Patent 5,476,427 discloses a pace display device utilizing a base rate for

traveling pre-set distances in successive trials. The device calculates step counts and rates, and compares actual step count rates to display data to a user for comparison of present running rates to previous rates.

Thus, there is a need for a simple, but highly accurate, pedometer that displays distance traveled, pace, speed, heart rate, and other important information on an easily read wrist-mounted device.

SUMMARY OF THE INVENTION

The present invention overcomes problems and shortcomings in the prior art by providing a device that includes a waist, chest, or leg-mounted stride counting device, a transmitter, and a wrist-mounted receiver/display device that provides highly accurate travel distances and other information. The device includes a computer that stores base stride length and rate data from traveling a pre-determined distance and compares that to actual stride rate data to calculate actual distance traveled, speed, and pace. The invention recognizes the interdependency of stride length and stride rate and uses that relationship to provide superior distance-calculating accuracy.

The invention also provides for improved display of relevant data on a wrist-mounted display that receives digital signals from devices worn on other body parts such as legs, waist, and chest. Transmitters that can send coded signals are desirable because they will not interfere with similar devices worn by other users in the vicinity.

The accuracy of the device can be enhanced using two different inventions. Both methods use an algorithm that adjusts a stride length based on actual stride rates. The two methods are known as the Shifting Curve method and the Unique Curve method. The Shifting Curve method uses a single algorithm that is modified to match an individual's running or walking characteristics. This algorithm is defined as: Actual Stride Length = Base Stride Length + Base Stride Length *(((Actual Stride Rate - Base Stride Rate) N)/Base Stride Rate); where N is either an average value or a derived value from a plurality of samples.

This method also includes a variation for calculating an actual stride length including steps of: timing a first user run of a predetermined distance; counting the

total number of strides in the user first run; dividing the first run distance by the stride count to obtain a base stride length; dividing the stride count by the first run time to obtain a base stride rate; counting strides during a user's second run to obtain an actual stride rate; calculating the actual stride length using the formula: Actual Stride Length = Base Stride Length + Base Stride Length *(((Actual Stride Rate - Base Stride Rate)N)/Base Stride Rate); wherein N is an average value or a derived value.

The average value variation can be refined by comparing Base Stride Rate to Actual Stride Rate to determine a percentage difference; and using N=1 when the Actual Stride Rate ≤ Base Stride Rate * 1.02 and using N=3 when Actual Stride Rate > Base Stride Rate * 1.02. One embodiment uses a plurality of sample runs over known distances to derive an accurate N value for each individual.

The preferred method is referred to as the Unique Curve method that creates a unique or custom curve for each individual reflecting the unique relationship between stride rate and stride length at two or more sample points, and the rate of change between, above, and below these points to obtain an accurate stride length for incremental changes in stride rate.

This method can be used in the present invention for walking only by: taking two walks of a known distance, but at significantly different paces - - one relatively slow and one relatively fast. The steps counted by the pedometer over the known distance can be used to calculate a steps per second rate for both walks. These rates can then be used to generate a graph or table by interpolating and extrapolating the two rates to arrive at a stride length for any reasonable rate being walked by the user. This stride length can then be used to calculate a highly accurate distance being walked by a user of the pedometer of the present invention.

When used for running only, or running and walking the Unique Curve method for calculating stride length is similar to the above walking method, except a total of five walks and runs are conducted over a fixed distance at a variety of rates. The five steps per second rates that are obtained are used to generate a curve derived by interpolating and/or extrapolating between the five rates and step lengths. The curve (or a chart) can be used during subsequent trips to find a very accurate stride

length for a given step rate. The curve is unique for each user, and in this manner, a highly accurate step length can be calculated from a given step rate to calculate distance traveled, accurate speeds, optimum heart rates, optimum workout times at given heart rates, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram of a pedometer in accordance with the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

As illustrated in Fig. 1, the present invention is directed to an improved pedometer 20 including: a waist, chest, or leg mounted stride counter 24, and a wrist or waist mounted display unit 26. An optional chest-mounted heart monitor 28 can be included. All of the device components are mounted in suitable housings. The pedometer 20 includes a data processor 30 that is mounted in the same housing as either the step counter 24 or the display unit 26.

The step counter 24 is an inertia device or any suitable device, such as a piezoelectric device, that counts the number of steps a user takes. The number of steps is transmitted to a data archive 32 either directly or via a transmitter 34. The data archive 32 is mounted in the housing with the step counter 24 or the display 26.

The transmitter 34 is mounted in the step counter housing and is preferably an Rf telemetric signal transmitter with a 30 inches to 36 inches transmission range. Alterriately, the transmitter is a wireless or wired digital transmitter with a coding function to limit or eliminate interference with other similar devices. The wireless transmission range is set between 30 inches and 36 inches to provide adequate range to transmit signals from a user's waist to wrist, but not so far as to cause interference with other Rf or digital devices in the vicinity.

The transmitter 34 transmits either raw data or calculated distances, pace, etc. to a wrist-mounted display unit receiver 40. The receiver 40 relays a raw data signal to the data processor 30 or a calculated data signal directly to the display panel 42, such as an LCD or LED.

Similarly, the heart rate monitor 28 includes a transmitter 44 that transmits heart rate data to the display unit 26. The heart monitor transmitter 44 can transmit at

the same or a different frequency as the stride counter 24, and to the same or a different receiver in the display unit 26. The heart rate transmitter 44 is preferably Rf, but can be digital for the reasons stated above. The range of the heart rate transmitter 44 should also be between 30 inches and 36 inches to ensure effective communication with the receiver while limiting outside interference.

The data processor 30 can also include a programmable logic controller, a personal computer, a programmable read-only memory, or other suitable processor. The data processor 30 includes a data archive 32 to store historic data on stride length and pace to be used in an algorithm for calculating actual distances, speed, and rate for real-time conversion of data to useful information for a user.

The data processor 30 can also include closed loop or fuzzy logic programming to continually or periodically replace the base stride rate and length with recently calculated stride rates and lengths so that long term conditioning trends are accommodated in the base stride archive. Incorporating trend capabilities may further enhance accuracy of the distance and pace calculations.

The display unit 26 also includes an operator interface 46 such as a key pad, button, knob, etc. that enables the user to start and stop a clock 48 (or stop watch) and activate various use modes within the pedometer, such as a sampling mode and operation mode. Any of these components may be voice-activated.

The Shifting Curve method for using the pedometer 20, requires the user to operate a "sampling mode" and begin walking or running a pre-determined distance such as a mile or 1600 meters, preferably on a running track of a known size. Upon completion of the distance, a stop button on the operator interface 46 is pushed. The data processor 30 is programmed to then divide the distance by the number of strides counted to calculate an average stride length. This value is stored in the data archive 32 as the "Base Stride Length."

Also, the data processor 30 is programmed to divide the number of strides by the time of the run or walk as measured by the clock 48 to arrive at a "Base Stride Rate."

The data processor 30 preferably includes programming that queries the user about the distance to be run during the sampling mode. By providing options or

enabling the use of any distance during the sampling mode, the pedometer 20 provides maximum flexibility for use by people of various physical conditions, or having access to courses of different known distances. Thus, a user may be queried to input a distance to be used in the sampling mode and then be given a list of options such as 400 meters, 440 yards, 1600 meters, or one mile, or be asked to simply input any distance known to the user that will be traveled during the sampling mode.

The present invention makes full use of the relationship between a faster rate of travel and longer stride lengths. In other words, the faster a user is moving, the longer will be the stride length. Over the course of the run or walk, the user's step rate and, therefore, stride length will change and the user will cover more ground when moving fast and less ground when moving slow.

Clearly, using a fixed average stride length in calculating distance traveled will result in errors using prior pedometers. This is particularly true if a user changes pace, or improves conditioning and speed to the point where the average stride length over a given run increases dramatically. The error compensators in prior devices do not adjust for changes in pace. With the old devices, a user needed to re-calibrate periodically to be close to getting an accurate reading, and could not change pace during a workout without decreasing accuracy.

Some devices may offer separate settings for walking and running, but there is no method for automatically adjusting for incremental changes in stride rate which would introduce erroneous stride length data and over time or distance significantly accumulate errors to the point of being ineffective.

To make the correction, the user activates a "Use Mode" in which the data processor 30 calculates an Actual Stride Rate based on data from the stride counter 24 and the clock 48. For example, an Actual Stride Rate can be calculated every five seconds without the user doing more than activating the " Use Mode" button, while all the calculations are performed by the data processor automatically. The percentage change between the Actual Stride Rate and the Base Stride Rate is then computed by the data processor 30 to determine an Actual Stride Length. Again, if the Actual Stride Rate is greater than the Base Stride Rate, the Actual Stride Length

is longer than the Base Stride Length. If the Actual Steps Per Second is lower than the Base Steps Per Second, the Actual Stride Length is shorter than the Base Stride Length. The algorithm below provides a means for comparing the Actual and Base Stride rates to arrive at an accurate Actual Stride Length.

First, a comparison between the Actual Stride Rate and the Base Stride Rate is made to determine whether Actual Stride Rate is less than or equal to Base Stride Rate multiplied by 1.02. Stride Length is calculated by:

Actual Stride Length = Base Stride Length +

Base Stride Length *(((Actual Stride Rate - Base Stride Rate)N)/Base Stride Rate)

Where: N=1 when Actual Stride Rate is less than or equal to Base Stride Rate multiplied by 1.02, and N=3 when Actual Stride Rate is greater than Base Stride Rate multiplied by 1.02, although other N values in the range of one to three can be used.

The above algorithm is accurate for heel to toe activities such as walking or jogging, but is less accurate for sprinting (toe only).

A third variation of the Shifting Curve method of calculating actual stride length uses three separate run or walk samples at three different paces. This is the most accurate variation of the Shifting Curve method. With this variation, the N values are unique for each individual. By deriving an N value for each individual, this value more accurately reflects the actual change in stride length with a change in pace. After a proper warmup, the user completes a sample run or walk on the track at a normal pace. This first sample S1, will establish the Base Stride and the Base Steps Per Second.

S1 SAMPLE:

S1 Stride = Base Stride = Distance / Number of Steps

S1 Steps Per Second or S1 Steps Per Second = Base Steps Per Second = Number of Steps Per Second

Following completion of the first run or walk at normal pace, the user runs or walks the same course and the same distance at a faster run or walking pace, but not a sprinting pace. The user should not run on his toes, but maintain the normal heel to

toe jogging style. This is the S2 sample. The purpose of the S2 sample is to calculate an N2 value for each individual which reflects the effect an increase in Steps Per Second has on this individual's stride length. Some individual's steps will lengthen more than others as Steps Per Second increases, and by finding the value for N2, this relative increase can be quantified for a more accurate and customized algorithm for each individual.

S2 SAMPLE:

To find the N2 value, which will be used by the algorithm when Actual Steps Per Second > Base Steps Per Second

N2 = ((S2 Stride * S1 Steps Per Second) - (S1 Stride * S1 Steps Per Second)) / (S1 Stride (S2 Steps Per Second - S1 Steps Per Second))

This value can be calculated since the distance is known, and both a Fast Stride Length (S2 Stride) and a Fast Steps Per Second (S2 Steps Per Second) can be calculated from the second sample.

Following completion of the fast run or walk, the user runs the same course and the same distance at a slower than normal run or walking pace. This pace cannot exceed the first sample pace. This is the S3 sample. The purpose of the S3 sample is to calculate an N3 value for each individual which reflects the effect a decrease in Steps Per Second has on this individual's stride length. Some individual's steps will shorten more than others as Steps Per Second decreases, and by finding the value for N3, this relative decrease can be quantified for a more accurate and customized algorithm for each individual.

S3 SAMPLE:

To find the N3 value, which will be used by the algorithm when Actual Steps Per Second < Base Steps Per Second.

N3=((S3 Stride * S1 Steps Per Second) - (S1 Stride * S1 Steps Per Second)) / (S1 Stride (S2 Steps Per Second - S1 Steps Per Second))

This value can be calculated since the distance is known and both a "Slow" Stride Length (S3 Stride) and a "Slow" Steps Per Second (S3 Steps Per Second) can be calculated from the third sample.

Once these three samples are completed and the information automatically

calculated and stored in the data processor 30, then the following formula can be used for the most accurate measurements of speed and distance.

If: Actual Steps Per Second is less than or equal to Base Steps Per Second

Then:

Stride Length = Base Stride + Base Stride*(((Actual Steps Per Second - Base Steps Per Second)N)/Base Steps Per Second)

And N = N3 (Stored Value)

If: Actual Steps Per Second > Base Steps Per Second

Then:

Stride Length = Base Stride + Base Stride*(((Actual Steps Per Second - Base Steps Per Second)N)/Base Steps Per Second)

And N = N2 (Stored Value)

This third variation for calculating stride length, and subsequently distance, speed, and pace, is a far more accurate method than a fixed stride length pedometer. This device and method are also practical, convenient, and has a relatively low manufacturing cost. If an individual's running or walking style is progressing with training and practice (as seen by significantly improved times), then it may be beneficial for them to recalibrate their device by repeating the three samples every 3 to 6 months. If there are no significant improvements in time, then recalibration is not necessary.

It is noted that any single stride length or pace discussed above can in fact be an average of a plurality of stride lengths or rates from test runs to further refine accuracy in the calculations of actual stride data.

A fourth calibration lap could be added to the above formulations, but another method can be used to provide even more accurate calculations and results. As stated above, stride length depends upon the number of strides per second a walker or runner takes. But the degree with which stride length varies relative to strides per second, varies among different individuals.

The Unique Curve method can also be used with the present invention. When used for walking only includes the steps of: taking two walks of a known

distance, but at significantly different paces - - one relatively slow and one relatively fast. The steps counted by the pedometer over the known distance can be used with the time of each walk to calculate a steps per second rate for each walk. These rates can then be used to generate a graph or table by interpolating and extrapolating the two rates to arrive at a stride length for any reasonable rate being walked by the user. This stride length can then be used to calculate a highly accurate distance being walked by a user of the pedometer of the present invention.

When used for running only, the method for calculating stride length is similar to the above walking method, except the points should be obtained during runs and it is preferable to obtain three runs. When used for walking and running the method is the same except that the points should be obtained during both walks and runs with preferably two walks and three runs. Using this latter approach, a total of five walks and runs are conducted over a fixed distance at a variety of rates. The five steps per second rates that are obtained are used to generate a curve derived by interpolating and/or extrapolating between the five rates and step lengths. The curve (or a chart) can be used during subsequent trips to find a very accurate stride length for a given step rate. The curve is unique for each user, and in this manner, a highly accurate step length can be calculated from a given step rate to calculate distance traveled, optimum heart rates, optimum workout times at given heart rates, etc.

Thus, using this Unique Curve method of calibration, a curve can be generated for a particular individual. A first alternate calibration option is preferred for individuals using the pedometer for walking only. It requires only two calibration walks. One is at normal speed, the other is at faster speed.

In a preferred embodiment it is desirable to show the calibration options and option number on the top line, and the description of the sampling pace on the bottom line of the display screen. Suitable LCD display screens can convey the necessary information to instruct the user on how to perform the calibration walks or runs.

After a Calibration Option is selected, and the track is selected, the user is ready to begin the two calibration walks required for this option. At this point, the LCD display will show 'WALK'.

The following steps are then followed.

1. After pressing MODE to select the correct calibration lap distance, the display would show that the user must now complete the first lap at their regular walking pace.

2. When the START button is pressed, the word 'WALK' will no longer be displayed, and the current calibration values will be displayed.

3. When STOP is pressed, the display will show the calibration results for five seconds. After five seconds, the results will go away, and the display will instruct the user to now complete the second lap at his or her fastest walking pace. This lap should be completed as fast as possible without breaking into running.'FAST WALK' will appear on the display.

4. When the START button is pressed, the words 'FAST WALK' will go away, and the current calibration values will be displayed.

5. When STOP is pressed, the display will show the calibration results for five seconds. If there is an error condition, then an 'ERR' message with the error number will display. If there is no error, then the display will flash "OK" five times, and then automatically exit calibration mode and return to the stop watch mode. The pedometer is then ready for use.

If the pedometer is to be used for both walking and running, the following calibration steps can be followed.

After the Calibration Option is selected, and the track is selected, the user is ready to begin the five calibration walks/runs required for option (Run & Walk).

Instructions 1 to 4 are identical to the first 4 steps immediately above.

6. When STOP is pressed, the display will show the calibration results for five seconds. After five seconds, the display changes to instruct the user that a run must be completed at a slow running pace. This slow run pace is as slow as possible without walking. 'SLOW RUN' will appear on the display.

7. When the START button is pressed, the words 'SLOW RUN' will go away, and the current calibration values will be displayed.

8. When STOP is pressed, the display will show the calibration results for five seconds. After five seconds, the display will change to instruct the user that a

run must be completed at a regular running pace. 'RUN' will appear on the display.

9. When the START button is pressed, the word 'RUN' will go away, and the current calibration values will be displayed.

10. When STOP is pressed, the display will show the calibration results for five seconds. After five seconds, the display will change to instruct the user that a run must be completed at a fast running pace. The runner should run a pace that does not require slowing down before completing this run. Failure to maintain a constant speed during calibration can cause errors. 'FAST RUN' will appear on the display.

11. When the START button is pressed, the words 'FAST RUN' will go away, and the current calibration values will be displayed.

12. When STOP is pressed, the display would show the calibration results for five seconds. If there is an error condition, the 'ERR' message with the error number would display. If there is no error, the display would flash "OK" five times, and then automatically exit calibration mode and return to the stop watch mode. The pedometer is now ready for use.

To assure that the calibration has been performed correctly, the data processor will perform the following error checks.

ERROR 1. If $T1<T2$ + 20 sec (400M) or +4 sec (100M) or +60 sec (1600M)
If $T2<T3$ + 20 sec (400M) or +4 sec (100M) or +60 sec (1600M)
If $T3<T4$ + 10 sec (400M) or +2 sec (100M) or 15 sec (1600M)
If $T4<T5$ + 10 sec (400M) or +2 sec (100M) or 15 sec (1600M)

ERROR 2. If $T1>T2$, and $SPS1>SPS2$;
If $T2>T3$, and $SPS2>SPS3$;
If $T3>T4$, and $SPS3>SPS4$;
If $T4>T5$, and $SPS4>SPS5$;
:then there will be an Error 2 readout. Repeat calibration.

ERROR 3. Consistent Pace Not Maintained. If five second average SPS varies more than +/- .20 from total average SPS during the calibration run, there will be an Error 3 readout and calibration should be repeated.

NO ERROR. If there is no error, the user is now ready to use the pedometer. The data processor will perform all the necessary calculations. The display will flash

"OK" five times and convert to stop watch mode.

Once the above data is collected in the pedometer, it is converted to useful stride length data using the following steps.

1. The data processor will construct a "Look-Up Table" to find an adjusted stride length value for each .05cm change in strides per second rate ("SPS").

2. SPS Table Range 1.50 to 3.00 (for walking only) or to 3.50 for running.

3. After the calibration laps are completed, the data processor will store in the Look-Up table the values for the first walk or run ("S1") and the second walk or run ("S2").

4. The data processor is programmed to then perform the following calculations.

a. S2 Stride Length - S1 Stride Length = ΔStride Length

b. S2 SPS (Steps Per Second) - S1 SPS = ΔSPS/.05 = Segment Divisor

c. Δ Stride Length/Segment Divisor = Rate of Change Value (ROCV).

5. The Rate of Change Value will be subtracted from each corresponding Stride Length Value for every .05 decrease in SPS below the S1 (normal walk pace) SPS value.

6. The Rate of Change Value will be added to each corresponding Stride Length Value for every .05 increase in SPS above the S1 (normal walk pace) SPS value.

SAMPLE 1

	TIME	STEPS	SPS	STRIDE
S1 WALK	272	545	2.00	73.30
S2 FAST WALK	210	479	2.28	83.50

	SPS	STRIDE	RATE OF CHANGE VALUE
	1.50	56.30	
	1.55	58.00	
	1.60	59.70	-
	1.65	61.40	

	1.70	63.10	
	1.75	64.80	
	1.80	66.50	
	1.85	68.20	
	1.90	69.90	
	1.95	71.60	
S1	**2.00**	**73.30**	**1.70**
	2.05	75.00	
	2.10	76.70	
	2.15	78.40	
	2.20	80.10	
	2.25	81.80	
S2	**2.30**	**83.50**	
	2.35	85.20	
	2.40	86.90	
	2.45	88.60	
	2.50	90.30	
	2.55	92.00	
	2.60	93.70	
	2.65	95.40	
	2.70	97.10	
	2.75	98.80	
	2.80	100.50	
	2.85	102.20	
	2.90	103.90	
	2.95	105.60	
	3.00	107.30	

The bold value represent S1 and S2 calibration values.

More data points are desirable when the pedometer is used for running only or when used for both walking and running. The following examples uses five data points ranging from a normal walk to a fast run.

This option is selected by people who will use the pedometer for running only, and for running and walking. Each person should complete a course of the same distance five times. The order for these five sample calibration runs is:

1. Normal Walk
2. Fast Walk
3. Slow Run
4. Normal Run
5. Fast Run

By completing the same distance five times at these different paces, the data processor will interpolate between the points and extrapolate using the same rate of change for any points below (very slow) or above (very fast). The first part of the set up is the calibration requires the user to set either centimeters or inches, and the track length, preferably 400 meters. A sample at 100 meters tends to yield greater deviations between calculated stride length and actual stride length. Further, 1600 meters tends to be too long a distance for a consistent pace to be maintained. Thus, the following calibration steps can be used with the pedometer of the present invention.

The data processor will perform all the following necessary calculations.

A. After the Calibration laps are completed, the data processor will store in the Look-Up table the values for S1 through S5.

B. The Look-Up Table will have an SPS Range of 1.50 to 3.50.

C. Formula for constructing the Look-Up Table values is:

i. S2 Stride Length - S1 Stride Length = ΔStride Length.

ii. S2 SPS (Steps Per Second) - S1 SPS = ΔSPS/.05 = Segment Divisor.

iii. Δ Stride Length/Segment Divisor = Rate of Change Value (ROCV).

D. The data processor will construct a Look-Up Table to find an adjusted stride length value for each .05cm change in SPS value.

E. This formula is repeated between each of the five sample points S1 to S5. There will be four different ROCV values.

F. The Rate of Change Value ROCV1 will be subtracted from each corresponding Stride Value for every .05 decrease in SPS below the S1 (normal walk pace) SPS value.

G. The Rate of Change Value ROCV1 will be added to each corresponding Stride Value for every .05 increase in SPS above the S1 (normal walk pace) SPS value and below the S2 value.

H. This pattern will be repeated for each of the next points through S5.

I. Above S5, the Rate of Change Value ROCV4 will be added to each corresponding Stride Value for every .05 increase in SPS above S5.

Sample 2

	TIME	STEPS	SPS	STRIDE
Walk	237	468	1.95	85.4
Fast Walk	189	437	2.3	91.5
Slow Jog	125	350	2.8	114.2
Norm Jog	102	303	3	132
Fast Jog	81	257	3.15	155.6

SPS	STRIDE	RATE CHANGE
1.50	77.67	
1.55	78.54	
1.60	79.41	
1.65	80.28	
1.70	81.15	
1.75	82.02	
1.80	82.89	
1.85	83.76	
1.90	84.63	
1.95	**85.50**	0.87
2.00	86.37	
2.05	87.24	
2.10	88.11	
2.15	88.98	
2.20	89.85	
2.25	90.72	
2.30	**91.50**	2.25
2.35	93.75	
2.40	96.00	

2.45	98.25	
2.50	100.50	
2.55	102.75	
2,60	105.00	
2.65	107.25	
2.70	109.50	
2.75	111.75	
2.80	**114.00**	4.5
2.85	118.50	
2.90	123.00	
2.95	127.50	
3.00	**132.00**	7.87
3.05	139.87	
3.10	147.74	
3.15	155.60	
3.20	163.47	
3.25	171.34	
3.30	179.21	
3.35	187.08	
3.40	194.95	
3.45	202.82	
3.50	210.69	

Sample 3

	TIME	STEPS	SPS	STRIDE
Walk	237	522	2.20	76.60
Fast Walk	179	452	2.55	88.40
Slow Jog	145	401	2.76	99.70
Jog	132	368	2.79	108.60
Fast Jog	106	310	2.92	129.00

SPS	STRIDE	RATE/CHANGE
1.80		
1.85		
1.90		
1.95		

2.00	69.84	
2.05	71.53	
2.10	73.22	
2.15	74.91	
2.20	76.60	1.69
2.25	78.29	
2.30	79.98	
2.35	81.67	
2.40	83.36	
2.45	85.05	
2.50	86.74	
2.55	88.40	2.82
2.60	91.22	
2.65	94.04	
2.70	96.86	
2.75	99.70	8.9
2.80	108.60	6.8
2.85	115.40	
2.90	122.20	
2.95	129.00	
3.00	135.80	
3.05	142.60	
3.10	149.40	
3.15	156.20	
3.20	163.00	

Sample 4

	TIME	STEPS	SPS	STRIDE
Walk				
Fast Walk				
Slow Jog	153.3	384	2.50	104.1
Jog	123.1	324	2.63	123.4
Fast Jog	96.2	266	2.77	150.3

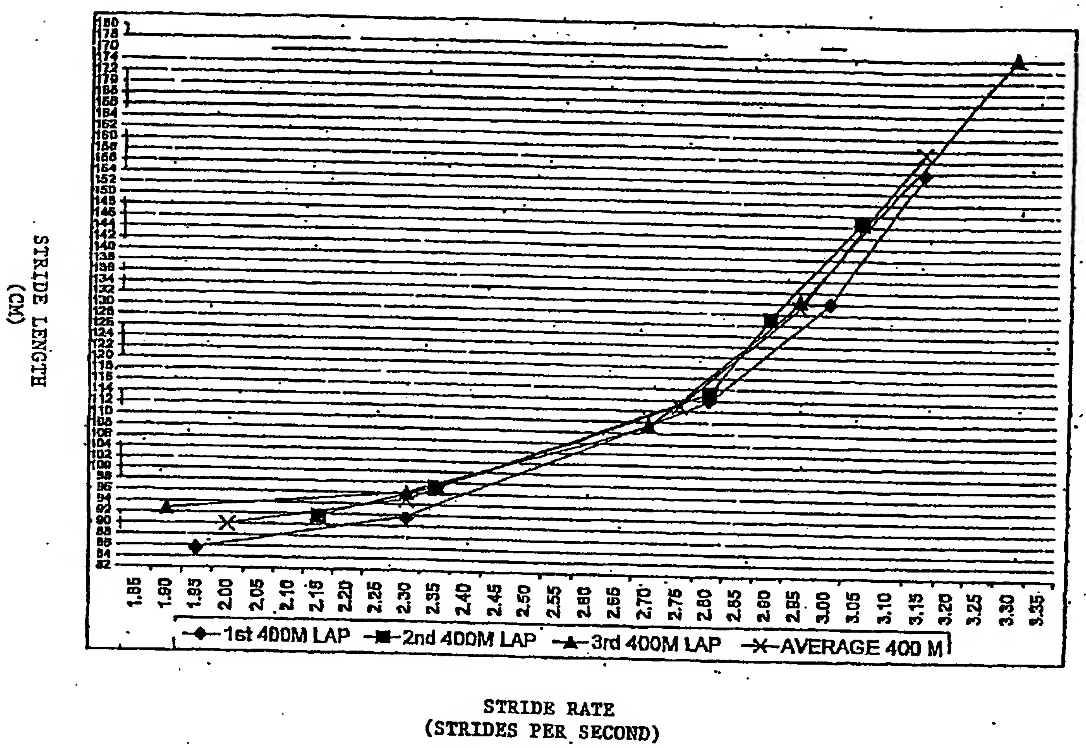
SPS	STRIDE	RATE/CHANGE
1.95		

2.00		
2.05		
2.10		
2.15		
2.20	65.52	
2.25	71.95	
2.30	78.83	
2.35	84.81	
2.40	91.24	
2.45	97.67	
2.50	**104.10**	6.43
2.55	110.53	
2.60	116.96	
2.65	123.40	13.45
2.70	136.85	
2.75	150.30	
2.80	163.75	
2.85	177.20	
2.90	190.65	
2.95		
3.00		
3.05		
3.10		
3.15		
3.20		

The bold values represent actual test calibration values.

In addition to taking single calibrations at each pace discussed above, a series of two or three calibrations can be taken at each pace and an average calibration figure can be used to create the Look-Up Table. Enhanced accuracy is possible using average calibrations. Below is a chart illustrating an example of such a method and it illustrates that accuracies within two percent are possible.

Sample 5


STRIDE LENGTH
(CM)
1st 400M LAP
2nd 400M LAP
3rd 400M LAP
AVERAGE 400 M
STRIDE RATE
(STRIDES PER SECOND)

Other variations on this device could also incorporate an altimeter which measures changes in elevation. The stride length could then be adjusted (shortened) when elevation is increasing, and lengthened when elevation is decreasing. This adjustment could be done with an average value, as we used in setting option 2, or with a derived value by running or walking over a known distance on a hilly course. This device can use two batteries so that the calibration data is not lost when the batteries are replaced one at a time.

Once the actual stride length is calculated for a given period of time, the value can be multiplied by the number of strides in that period to obtain a total distance for that period to be stored in a data archive file for that particular walk or run and added to other actual stride lengths or distances for other periods in which stride length was calculated. When the run or walk is completed, the user engages the operator interface 46 to indicate that a total distance is to be displayed on the display unit. There can also be a continual display of the distance traveled.

As a result of accurately calculating distance traveled, the pedometer 20 also has the capability of calculating speed in miles per hour, for example or pace in minutes per mile, including average speed and pace over the course of that particular walk or run. Further, the pedometer 20 can include a port for coupling to a separate personal computer or computing device to create larger training histories, trends, etc.

Additional features can include stop watches, day, date and time displays, as well as; heart rate displays as discussed above. Also, it will be understood that all distances and time periods used above can be varied in length and units of measure (English, metric, seconds, minutes, hours, etc.).

Using such sophisticated and accurate methods for calculating pace and distance traveled, a user can determine optimum work out lengths and paces. The data processor can either calculate optimum work out conditions or the user or trainer/coach can input the optimum conditions. Once these conditions are known, the pedometer can signal the user during a workout as to whether optimum conditions are being met. A sound signal or message on the screen can be used to convey this information.

Also, the data can be sent to a computer or directly to an Internet site via a

wireless or cable system at the completion of a workout. Once in the data is collected it can be used to provide a variety of comparisons and development charts to aid in training of individuals users.

The foregoing detailed description is provided for clearness of understanding only and no unnecessary limitations therefrom should be read into the following claims.

CLAIMS

1. A pedometer comprising:

a step counter mountable on a user first body portion;

a transmitter in communication with the step counter to generate a signal corresponding to each step and transmit the signal; and

a receiver mountable on a user second body portion to receive the signal transmitted from the transmitter and calculate a distance measured by the step counter.

2. The pedometer of claim 1, wherein the transmitter and the receiver communicate via wireless transmission.

3. The pedometer of claim 1, wherein the transmitter and the receiver communicate via a wire.

4. The pedometer of claim 1, wherein the transmission signal is digitally coded.

5. The pedometer of claim 1, where in the transmitter transmits the signal a wireless distance in the range of thirty to thirty-six inches.

6. The pedometer of claim 1, wherein the receiver is mountable on a user's wrist.

7. The pedometer of claim 1, wherein the receiver processes the step count signal and displays the distance traveled on a viewing screen.

8. The pedometer of claim 1, wherein the step counter is mountable on a user's leg.

9. The pedometer of claim 1, and further comprising:

a heart rate monitor; and

a second transmitter in communication with the heart rate monitor to transmit a signal corresponding to a heart rate calculated by the heart rate monitor to the receiver and display the calculated heart rate.

10. The pedometer of claim 9, wherein the heart rate signal is at a different frequency than the pedometer signal.

11. The pedometer of claim 9, wherein the heart rate monitor is mountable to a user's third body portion.

12. The pedometer of claim 9, wherein the heart rate and the step counter transmitter are mounted in a single chest-mount housing.

13. The pedometer of claim 1, wherein the pedometer includes a data processor programmed to calculate a distance traveled by multiplying the number of strides taken by a stride length that varies according to the rate at which strides are taken.

14. The pedometer of claim 13, wherein the data processor is programmed to calculate an actual stride length of a user by performing the steps of:

timing a user first run of a predetermined distance;

counting the total number of strides in the user first run;

dividing the first run distance by the stride count to obtain a base stride length;

dividing the stride count by the first run time to obtain a base stride rate;

counting strides in a period of time during a user second run to obtain an actual stride rate;

calculating the actual stride length using the formula:

Actual Stride Length = Base Stride Length + Base Stride Length *(((Actual Stride Rate - Base Stride Rate)N)/Base Stride Rate);

where N is in the range of between 1 and 3.

15. The pedometer of claim 13, wherein the pedometer is further programmed to perform the steps of:

comparing the actual stride rate to the base stride rate; and

calculating the actual stride length using N=1 when the actual stride rate is less than or equal to the base stride rate multiplied by 1.02.

16. The pedometer of claim 13, wherein the pedometer is further programmed to perform the steps of:

comparing the actual stride rate to the base stride rate; and

calculating the actual stride length using N=3 when the actual stride rate is greater than the base stride rate multiplied by 1.02.

17. A pedometer comprising:

a step counter;

a transmitter in communication with the step counter to generate a signal corresponding to each step and transmit the signal; and

a receiver mountable on a user body portion to receive the signal transmitted from the transmitter and calculate a distance measured by the step counter; and

a data processor programmed to calculate a distance traveled by multiplying the number of strides taken by a stride length that varies according to the rate at which strides are taken.

18. The pedometer of claim 17, wherein the transmitter and the receiver communicate via wireless transmission.

19. The pedometer of claim 17, wherein the transmitter and the receiver communicate via a wire.

20. The pedometer of claim 17, wherein the transmission signal is digitally coded.

21. The pedometer of claim 17, where in the transmitter transmits the signal a wireless distance in the range of thirty to thirty-six inches.

22. The pedometer of claim 17, wherein the receiver is mountable on a user's wrist.

23. The pedometer of claim 17, wherein the receiver processes the step count signal and displays the distance traveled on a viewing screen.

24. The pedometer of claim 17, wherein the step counter is mountable on a user's leg.

25. The pedometer of claim 17, and further comprising:

a heart rate monitor; and

a second transmitter in communication with the heart rate monitor to transmit a signal corresponding to a heart rate calculated by the heart rate monitor to the receiver and display the calculated heart rate.

26. The pedometer of claim 25, wherein the heart rate signal is at a different frequency than the pedometer signal.

27. The pedometer of claim 25, wherein the heart rate monitor is mountable to a user's third body portion.

28. The pedometer of claim 25, wherein the heart rate and the step counter are mounted in a single chest-mount housing.

29. The pedometer of claim 17, wherein the data processor is programmed to calculate an the distance traveled actual stride length of a user by performing the steps of:

timing a user first run of a predetermined distance;

counting the total number of strides in the user first run;

dividing the first run distance by the stride count to obtain a base stride length;

dividing the stride count by the first run time to obtain a base stride rate;

counting strides in a period of time during a user second run to obtain an actual stride rate;

calculating the actual stride length using the formula:

Actual Stride Length = Base Stride Length + Base Stride Length *(((Actual Stride Rate - Base Stride Rate)N)/Base Stride Rate);

where N is in the range of between 1 and 3.

30. The pedometer of claim 17, wherein the pedometer is further programmed to perform the steps of:

comparing the actual stride rate to the base stride rate; and

calculating the actual stride length using N=1 when the actual stride rate is less than or equal to the base stride rate multiplied by 1.02.

31. The pedometer of claim 17, wherein the pedometer is further programmed to perform the steps of:

comparing the actual stride rate to the base stride rate; and

calculating the actual stride length using N=3 when the actual stride rate is greater than the base stride rate multiplied by 1.02.

32. A pedometer programmed to calculate an actual stride length of a user by performing the steps of:

timing a user first run of a predetermined distance;

counting the total number of strides in the user first run;

dividing the first run distance by the stride count to obtain a base stride length;

dividing the stride count by the first run time to obtain a base stride rate;

counting strides in a period of time during a user second run to obtain an actual stride rate;

calculating the actual stride length using the formula:

Actual Stride Length = Base Stride Length + Base Stride Length *(((Actual Stride Rate - Base Stride Rate)N)/Base Stride Rate);

where N is in the range of between 1 and 3.

33. The pedometer of claim 32, wherein the pedometer is further programmed to perform the steps of:

comparing the actual stride rate to the base stride rate; and

calculating the actual stride length using N=1 when the actual stride rate is less than or equal to the base stride rate multiplied by 1.02.

34. The pedometer of claim 32, wherein the pedometer is further programmed to perform the steps of:

comparing the actual stride rate to the base stride rate; and

calculating the actual stride length using N=3 when the actual stride rate is greater than the base stride rate multiplied by 1.02.

35. The pedometer of claim 32, wherein the receiver processes the step count signal and displays the distance traveled on a viewing screen.

36. The pedometer of claim 32, and further comprising a heart rate monitor mounted in a chest-mount housing.

37. A pedometer programmed to calculate an actual stride length of a user by performing the steps of:

timing a user first run of a predetermined distance;

counting the total number of strides in the user first run;

dividing the first run distance by the stride count to obtain a first run base stride length;

dividing the first run stride count by the first run time to obtain a first run base stride rate;

timing a user second run of a predetermined distance;

counting the total number of strides in the user second run;

dividing the second run distance by the second run stride count to obtain a second base stride length;

dividing the second run stride count by the second run time to obtain a second base stride rate;

timing a user third run of a predetermined distance;

counting the total number of strides in the user third run;

dividing the third run distance by the third run stride count to obtain a third base stride length;

dividing the third run stride count by the third run time to obtain a third run base stride rate;

counting strides in a period of time during a user fourth run to obtain an actual stride rate;

calculating the actual stride length using the formula:

Actual Stride Length = Base Stride Length + Base Stride Length *(((Actual Stride Rate - Base Stride Rate)N)/Base Stride Rate); where N is calculated by the formula ((Second Run Stride Length multiplied by First Run Stride Rate) - (First Run Stride Length multiplied by First Run Stride Rate)) / (First Run Stride Length multiplied by (Second Run Stride Rate - First Run Stride Rate)) when the Actual Stride Rate is greater than the First Run Stride Rate, and where N is calculated by the formula ((Third Run Stride Length

multiplied by First Run Stride Rate) - (First Run Stride Length multiplied by First Run Stride Rate)) / (First Run Stride Length multiplied by (Third Run Stride Rate - First Run Stride Rate)) when the Actual Stride Rate is less than or equal to the First Run Stride Rate.

38. The pedometer of claim 37, wherein:

the first run base stride length is an average stride length calculated from a plurality of test runs; and

the first run base stride rate is an average base stride rate calculated from the plurality of test runs.

39. The pedometer of claim 37, wherein:

the second run base stride length is an average stride length calculated from a plurality of test runs; and

the second run base stride rate is an average base stride rate calculated from the plurality of test runs.

40. The pedometer of claim 37, wherein:

the third run base stride length is an average stride length calculated from a plurality of test runs; and

the third run base stride rate is an average base stride rate calculated from the plurality of test runs.

41. The pedometer of claim 37, wherein the second run is at a faster pace than the first walk or run and the third run is at a slower pace than the first walk or run.

42. The pedometer of claim 37, and further comprising:

a data processor mountable on a user body portion to calculate the actual stride length; and

a run data display device in communication with the data processor and mountable on a user body portion.

43. The pedometer of claim 37, and further comprising a heart rate monitor mounted in a chest-mount housing.

44. A method for calculating an actual stride length comprising the steps of:

timing a first user run of a predetermined distance;

counting a total number of strides in the user first run;

dividing the first run time by the stride count to obtain a Base Stride Length;

dividing the stride count by the first run time to obtain a Base Stride Rate;

counting strides in a pre-determined period during a user second run to obtain an Actual Stride Rate;

calculating the actual stride length using the formula:

Actual Stride Length= Base Stride Length + Base Stride Length *(((Actual Stride Rate - Base Stride Rate)N)/Base Stride Rate);

wherein N is between one and three.

45. The method of claim 44 and further comprising the steps of comparing Base Stride Rate to Actual Stride Rate to determine a percentage difference; and using N=1 when the difference is less than two percent and using N=3 when the difference is greater than or equal to two percent.

46. The pedometer of claims 13 or 17, wherein the data processor is programmed to calculate an actual stride length of a user by performing the steps of:

timing a user first walk or run of a predetermined distance;

counting the total number of strides in the user first walk or run;

dividing the total number of strides by the time of the first walk or run to arrive at a strides per second rate for the first walk or run;

timing user second walk or run of a predetermined distance;

counting the total number of strides in the user second walk or run;

dividing the total number of strides by the time of the second walk or run to arrive at a strides per second rate for the second walk or run;

interpolating between the strides per second of the first and second walks or runs to obtain a range of stride lengths corresponding to stride per second rates between the strides per second rates of the first and second walks or runs; and

using the range of stride lengths to calculate distance traveled that correspond to strides per second rates in subsequent walks or runs.

47. The pedometer of claim 46, wherein the data processor is further programmed to:

timing a third user first walk or run of a predetermined distance;

counting the total number of strides in the user third walk or run;

dividing the total number of strides by the time of the third walk or run to arrive at a strides per second rate for the third walk or run;

interpolating between the strides per second rates of the first, second, and third walks or runs to obtain a range of stride lengths corresponding to a range of strides per second rates; and

using the range of strides lengths to calculate distance traveled that corresponds to strides per second rates in subsequent walks or runs.

48. The pedometer of claim 46, wherein the data processor is further programmed to perform the steps of:

extrapolating the range of stride lengths below and above the stride lengths of the first and second walks or runs.

49. A pedometer comprising:

a housing;

a stride counter mounted in the housing;

a clock for timing a length of a walk or run mounted in the housing;

a data processor mounted in the housing to calculate a distance traveled by multiplying a number of strides by a stride length that varies according to the rate at which strides are taken.

50. The pedometer of claim 49, wherein the data processor calculates a stride length after being calibrated using the following steps:

timing a first walk or run;

counting the steps in a first walk or run;

calculating a stride rate for the first walk or run;

timing a second walk or run;

counting the steps in a second walk or run;

calculating a strides rate for the second walk or run; and

comparing the stride rates from the first and second walks or runs to derive a range of stride lengths corresponding to a range of strides rates.

51. The pedometer of claim 50, wherein the method of calibration further includes the steps of:

timing a third walk or run;

counting the steps in a third walk or run;

calculating a stride rate for the third walk or run; and

comparing the stride rates from the first, second, and third walks or run to derive a range of stride lengths corresponding to a range of stride rates.

52. The pedometer of claim 49, and further comprising:

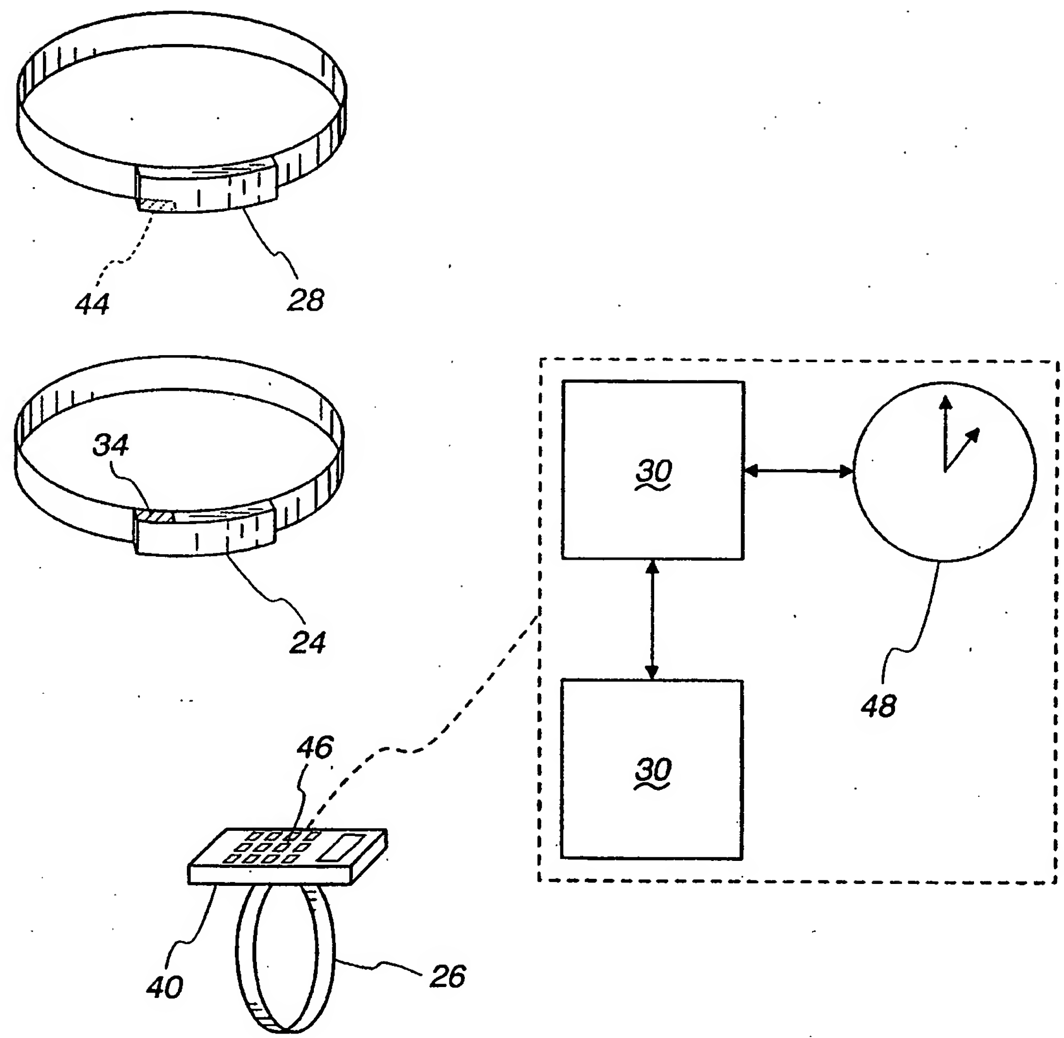
a heart rate monitor for monitoring a user's heart rate at a variety of stride rates; and

the data processor is programmed to compare heart rates to stride rates.

53. The pedometer of claim 49, wherein the data processor includes:

an interface for communicating with another data processor.

54. The pedometer of claim 49, wherein the data processor causes a display on the pedometer to guide a user through the steps of a calibration method.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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/25314

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01C22/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 033 013 A (KATO YASUJI ET AL) 16 July 1991 (1991-07-16) column 7, line 25 - line 30 column 8, line 21 - line 28 abstract	1-3,5-7, 13, 17-19, 21-23,49
A		14,29, 32,35, 37,44

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search	Date of mailing of the international search report
6 March 2000	13/03/2000

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/25314

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 119 009 A (NIKE INTERNATIONAL LTD) 19 September 1984 (1984-09-19)	1,2,5-7, 13
A	page 6 page 10 page 11	14,17, 18, 21-23, 27,49
X	US 4 371 945 A (KARR LAWRENCE J ET AL) 1 February 1983 (1983-02-01) cited in the application column 4, line 33 -column 5, line 26	1,2,6-8, 17
X	US 5 583 776 A (LEVI ROBERT W ET AL) 10 December 1996 (1996-12-10)	49,53,54
A	column 6, line 6 - line 42; claim 14; figures 5,7 abstract	32,35, 44,50

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/25314

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5033013 A	16-07-1991	JP 62032936 A	12-02-1987
EP 0119009 A	19-09-1984	US 4578769 A	25-03-1986
		CA 1218455 A	24-02-1987
		JP 59171564 A	28-09-1984
US 4371945 A	01-02-1983	NONE	
US 5583776 A	10-12-1996	NONE	